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BULLETIN

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THE PLATEAU OF THE SAN FRANCISCO PEAKS IN ITS EFFECT ON TREE-LIFE.

BY

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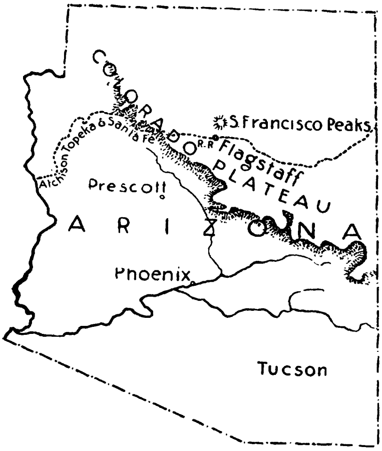
I.

In the northern part of the territory of Arizona lies one of the most interesting regions of the globe. A long pine-covered plateau, seventy miles across, rises there out of the great American Desert, which by its character and situation affords exceptional insight into three worlds: our world that is, our world that was, and, lastly, such worlds as people space. All three opportunities owe circumstance to the same cause, the desert attribute of the land. Dryness of climate, which commends it for astronomic observation, furthers mundane research as well. For, just as absence of moisture has opened the heavens, so it has sealed the earth to its better understanding to-day. Lack of deposition in the past and slow detrition now have preserved the earth's records there in a perfection unattainable ordinarily. Little has happened to destroy them since the beginning of Tertiary times, with the result that one wanders through a petrified forest dating from the Cretaceous era yet looking as if its trees had fallen yesterday; or treads upon lava-beds so fresh of mien they suggest ejection of the day before which, in truth, have lain there for millions of years. Even human habitations may still be visited in cliff and cave dwellings of which the artificial stone-work and utensils are so perfect that they seem but just abandoned, yet of which no certain traditional memory survives.

Due indirectly to the like cause is the opportunity of studying there some generic aspects of the world of to-day. For the desert character of the country has conduced to keeping it virgin of man's destruction until the advent of the lumberman a few years ago; while the altitude of the plateau, upon which, as on a dais, are set the San Francisco Peaks themselves nearly 13,000 feet in height, gives base to a corresponding rise in climatic conditions which epitomize within a few thousand feet of climb the flora through as many thousand miles of latitude.

Tokoschli (Wrapped in Cloud), as the Indians call the Peaks, not only makes, at times, a cloud islet in the vast blue sky of the desert, but is itself a geographic island for animals and plants. For the mountain mass rises in self-contained seclusion out of the surrounding waste, bearing on it an organic world of its own. Upon its slopes grow trees and flowers quite unlike those at its foot, vegetation whose congeners are found far north, sundered from these outlying waifs by hundreds of miles of void. Organically insular, it is not so much a single island as a series of such, rising in tiers one above the other. For, beginning from the desert, no less than seven zones of vegetal and animal life are here set vertically on end, each complete in itself and exclusive of its neighbours. They reproduce in superposed succession the several floral and faunal zones one would traverse were he to journey thence northward to the pole.



Height above sea level is the first factor in their determination, their altitudinal ordering being as follows:

1.	The Desert Zone................	from	sea-level to 5,500 feet.
2.	The Piñon Zone.................	"	5,500 feet " 6,500 feet.
3.	The Pine Zone..................	"	6,500 feet " 8,500 feet.
4.	The Fir Zone...................	"	8,500 feet " 10,300 feet.
5.	The Spruce Zone................	"	10,300 feet " 11,500 feet.
6.	The Timber-line Zone...........	"	11,500 feet " 12,100 feet.
7.	The Alpine Zone................	"	12,100 feet " 12,610 feet.

They correspond to those occurring at sea-level in latitude:

1.	25°-30°.	The Sub-tropical.
2.	30°-35°.	The Intermediate.
3.	35°-40°.	The Temperate.
4.	40°-50°.	The Canadian.
5.	50°-60°.	The Hudsonian.
6.	60°-70°.	The Arctic.
7.	70° northward.	The Polar.

TREES

OF THE DIFFERENT ZONES OF THE SAN FRANCISCO REGION.

DESERT ZONE—to 5,500 ft.

I. Treeless.

PIÑON ZONE—5,500-6,500 ft.

II. Piñon. *Pinus Edulis.* Its central habitat is about 6,300 ft.; but on south exposures it climbs as high as 7,250 ft. (and even in one instance 8,100 ft.). Found thus on Observatory Mesa—very sparsely.

Cedar. *Juniperus occidentalis monosperma.* Habitat the same. Found on Anderson Mesa owing to southern slope exposure as high as 7,000 ft. Gives its name to the zone which is called in consequence the Cedar belt.

Juniper. *Juniperus pachyphloea.* A giant dwarf. A very handsome tree for its checkerboard bark. Often twelve feet in girth and but twenty-five feet high. Grows in the belt and rises somewhat higher than its associates; being common on the S.W. slope of Elden Mt. and sparsely on Observatory Mesa, at altitudes of 7,000-7,300 ft.

PINE ZONE—6,500-8,500 ft.

III. Alligator or Yellow Pine. *Pinus ponderosa.* Long straight needles in long sheathes of three, at times two, straggling. Bark bronze red with long furrows between. In the variety known as Black Jack the bark is black, in deep longitudinal furrows without trace of red. This is not only the characteristic but almost the only tree of the zone—ranging in elevation of habitat from 6,500 ft. to 8,500 ft. On the North slope of the San Francisco Peaks a fine specimen, ten feet in girth, I found at an altitude of 9,000 ft., which may be taken as its extreme upper limit.

White Oak. *Quercus Ganbelii.* Common on the slopes of the mesa, at altitudes of 7,000-8,400 ft. Grows on the very top of Mormon Mt., where it is plentiful. Fringes all the mesas—and turns a beautiful yellow the middle of October. Seedlings turn red.

Holly Oak. *Quercus Ilex.* A single specimen of this apparently unknown tree exists on the south slope of the Observatory Mesa. It differs from the oaks, *Quercus Ganbelii*, about it, by the holly-like points of its leaves and by having its acorns stalked not sessile.

June-berry. *Amelanchier Canadensis*, western variety. Of smaller leaves and stockier habit than its eastern relative. A rarish tree-shrub but growing here and there at elevations of about 7,000 ft. Found near Flagstaff to the north. One specimen on the Observatory Mesa.

FIR ZONE—8,500-10,300 ft.

IV. Douglas Fir. *Pseudotsuga Douglasii.* This superb tree is chiefly striking for the pale bronze of the largely furrowed bark. Its leaves show relationship to the

Hemlock, and differ from those of the Silver Fir, with which it is commonly associated by their less regular branchings and more feathery appearance. Its normal range is from 8,400 ft. to 10,300 ft. On northern slopes it descends lower, according to the plateau on which the rise stands, coming down on Mormon Mt. as low as 7,200 ft.

Silver Fir. *Abies concolor.* This tree, the Silver Fir of our eastern parks and gardens, grows at the same elevation as the Douglas Fir, being common on Elden Mt. and Mormon Mt. and southward on the hillocks. It is also found in the crater of the San Francisco Peaks, but is rare on their outer slopes. In bark it slightly resembles the Douglas Fir, but is much less pronounced both in furrows and tint. Its needles serve to distinguish it, being coarser, longer and recurved, flattening the leaf-base. Its twigs, too, are the stubbier.

THE PINE PLATEAU.
(*Pinus Ponderosa.*)

Cork Fir. *Abies subalpina.* A pictorial tree for the whiteness of its bark and the silvery sheen of its symmetrical young shoots. The chief tree in the interior of the crater of the San Francisco Peaks at elevations from 9,000 ft. to 10,100 ft. It also clothes the Peaks' outer slopes both on the southwest and on the north sides at from 9,500 ft. to 10,700 and 10,840 ft. respectively.

Rocky Mountain Pine. *Pinus Flexilis.* Needles in short sheathes of five at the ends of the branches. Bark silvery when young; black and closely scaled when old. Less plentiful than the firs and in localities absent where they are common. Its bark and dark green leaves give it a sombre look at a distance. It is the white pine of the west though quite unlike *Pinus Strobus* in appearance. Cones very large, six inches long and often starring the branches in threes or more.

Quivering aspen. *Populus tremuloides.* The only gorgeous bit of color at the turn of the leaf in the region is given by this tree, which in mid-October blazons the sides of the Peaks and high land round about with gold and orange, banding the mountain side in patches, at elevations of from 8,000 to 10,300 ft., and in rocky gulches ribboning them down to 7,100 feet.

SPRUCE ZONE—10,300–11,500 ft.

V. White or Engelmann Spruce. *Picea Engelmanni.* The white spruce of the west. It is the tree of the highest elevations climbing in company with the Fox-Tail Pine to the timber-line. It begins to appear on the south face of the Peaks at 10,230 ft., and passes up through the zone into the Timber Line Zone above it; its upper limit as a tree being 11,500 ft.

BOLE OF DOUGLAS FIR.
(*Pseudotsuga Douglasii.*
Hill south of Mormon Mt. 7,500 Ft.

Fox-Tail Pine. *Pinus Aristata.* Curved needles in sheathes of five, closely ranged for six to eight inches along the ends of the branches; the needles looking inward and giving the effect of a fox's brush. The bunches longer than in the Rocky Mountain Pine and more appressed. The tree's limits begin higher with those of the Engelmann Spruce at 10,680 ft., or 10,160 ft., according to exposure, but at the top are practically identical with them. The two form the only trees in the zone which extend from 10,340 to 11,500 ft., and, above 10,700 ft., share the ground equally between them.

TIMBER LINE ZONE—11,500–12,100 ft.

VI. This is the zone in which the only two trees that can mount so high, the

Engelmann Spruce and the Fox-Tail Pine, struggle as gnarled dwarfs for precarious existence. Nearly prostrate along the rocks they cling, bowed down not two feet from the ground, climbing crouched up in one place on the southwest slope even to the crater rim. They cease to be trees at 11,500 or less, according to the exposure, and give up the struggle entirely at 12,080 ft., beyond which rises the naked rock, bare except for a few small plants.

ALPINE OR ARCTIC ZONE—12,100–12,610 ft.

VII. The pinnacles of the Peaks constitute this barren zone, which also descends in places down their flanks, reaching as low as 11,850 ft. and rising in Frémont to 12,100 ft., in Agassiz to 12,340 ft., and in Humphrey to 12,610 ft.

YOUNG SILVER FIR.
Top of hill, south of Mormon Mt. 7,900 Ft.

In describing the trees, an eye has been had to their identification; the object, one would suppose, of botanical treatises generally, if he had never consulted such. For what clear idea of separate identity is conveyed by defining the bark of one species as appressed and afurrowed and that of another as furrowed and appressed; or that the needles of one pine are from 3 to 10 inches long and those of a second from 4 to 7, even when that excellent shibboleth "pubescent," a favourite with this class of writers, is thrown in to boot? On the other hand, to say of the *Pinus ponderosa* (Yellow Pine), the *Pinus Flexilis* (Rocky Mountain Pine), and the *Pinus Aristata* (Fox-Tail Pine), that they respectively wear their hair unkempt, cut and curled, is to give the unknowing instant recognition of the three trees at sight.

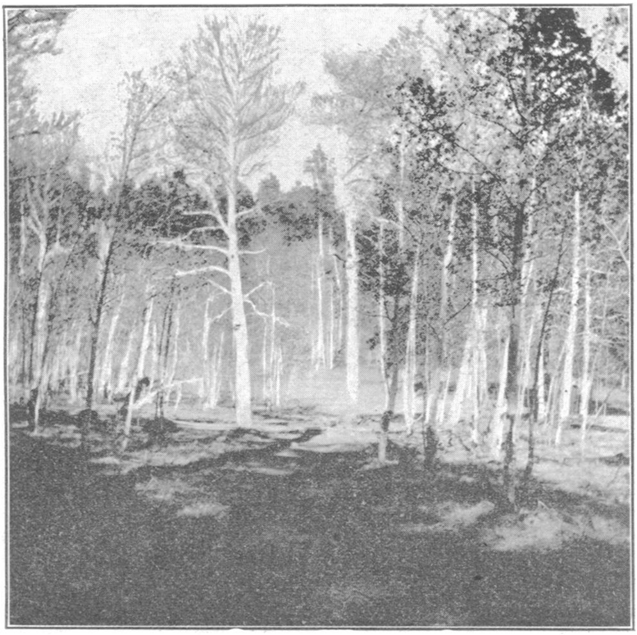
These several zones of vegetation topographize the country as with contour lines. For their chief determinant is elevation, because of the colder climate height brings about. They are, in fact, a complicated series of isotherms.

That it is the cold of elevation and not some other consequence of it is patent from the behaviour of the trees themselves. That thinness of air directly has nothing to do with it is shown not only by the identity of the species here at high altitudes with those at sea-level farther north, but by trees *in situ* within a few miles of one another. Thus the Douglas Fir is to be found in the bottom of Walnut Cañon, at 6,000 feet, where the walls are precipitous enough partially to exclude the sun, though Yellow Pine alone grows upon the rim, and its own congeners are not to be met without rising 2,500 feet. It exists, too, in the Cañon, side by side with Black Walnut, Ash-leaved Maple, and such distinctively western species. In the wider and more exposed Oak Creek Cañon at 5,000 feet, where these same trees and the fine Oregon alder flourish, it is

CORK FIR.
S. W. Slope of San Francisco Peaks. 10,000 Feet.

absent. But cold also shows itself as cause in the fact that other factors beside elevation, pure and simple, play their part in thus allotting the several habitats of the trees. Slope-exposure is one of them. On the southern flanks of the Peaks and on the southern slopes of the lesser cones and summits of the region, the successive tree-lines are all pushed up, while on the northern they descend, and this to a difference of more than a thousand feet.

To the study of this factor, the character of the country has again most excellently contributed. For the elevations that rise above the general level of the plateaux are, for the most part, cones of volcanic origin and cones of singularly symmetric shape. Since the close of the secondary period of the Earth's geologic history, that of Mesozoic times, the only great force at work here has been volcanic. After the disappearance of the inland sea which once overspread the region and continued as late as the Cretaceous era, the country became the theatre of vast extrusive action. The Peaks themselves are but the remains of a great crater wall of unknown antiquity; while all around them are smaller cones, the lava flows of which are still patent in the mesas at their feet. The mesa upon



QUIVERING ASPEN.
San Francisco Peaks. About 9,000 Ft.

which the Observatory stands is one of them, its malapais rock being the ancient lava, and its edge, overlooking Flagstaff, marking where that lava stopped; while a walk of four miles back upon it will bring one to Crater Hill and to the vent in its crater whence the flow poured forth.

The circularity of the cones simplifies the study of slope-exposure. For the approximate symmetry to the cardinal points sifts their effect from any others with something of the scientific exactness of a laboratory experiment. The cones are high enough to bring two or more of the zones into investigation, until in the case of the Peaks all are involved.

ENGLEMANN SPRUCE. FOX TAIL PINE. CORK FIR.
S. W. Slope San Francisco Peaks. 10,700 Ft.

But a third factor is concerned in the establishment of a species habitat: the mass of land at the given height. It is not the absolute altitude alone that determines a tree's presence, but the amount of land at that altitude. A plateau at the same elevation acts very differently from a peak. It was to this point that the present research was particularly directed. The result justified expectation.

The investigation was conducted from the Observatory for base, through excursions and camping trips made by the director. The

Observatory itself lies in the pine zone at an altitude of 7,250 feet on the southeast edge of a mesa, 350 feet above the town of Flagstaff. Besides the pine, the edges of the mesa are fringed with a growth of white oak (*Q. Gambelii*), which extends back from the rim a few hundred yards and then curiously comes to an end. The trees, though rarely over thirty feet high, are of good girth, one within a stone's-throw of the house measuring eleven feet in circumference. When old, they become hollow and make homes for bees; and when they die are frequently replaced by a circular thicket of the next generation. Perhaps a fifth as numerous as the pines, they divide with the latter the ground which they sparsely but regularly stud after the manner of an English park. A quarter of a mile away from the edge, the pines possess the mesa alone. The mature character of the trees, standing dignifiedly apart with just enough seedlings to keep up the race and replace the fallen ones that are turning slowly again to loam, shows that, except where the lumbermen have been, we here gaze on the primeval forest.

CAMP IN CRATER OF SAN FRANCISCO PEAKS.
Cork Fir. 9,350 Ft.

In the expeditions taken from this base, the heights at which particular species of trees were found were got by an aneroid checked to agree with certain fundamental altitudes obtained from two trigonometric surveys. Necessary not only for the determination of the tree zones, it was essential also for the establishment of the general topography. For the government map was a creation of more artistic than scientific value, in which many of the depictions rose superior to fact. The new survey by Mr. Pearson Chapman promises to give us something in accordance with reality. From his survey, which agrees with the trigonometric determinations of Mr. A. E. Douglass in 1898, then of this Observatory, the following fundamental heights were obtained:

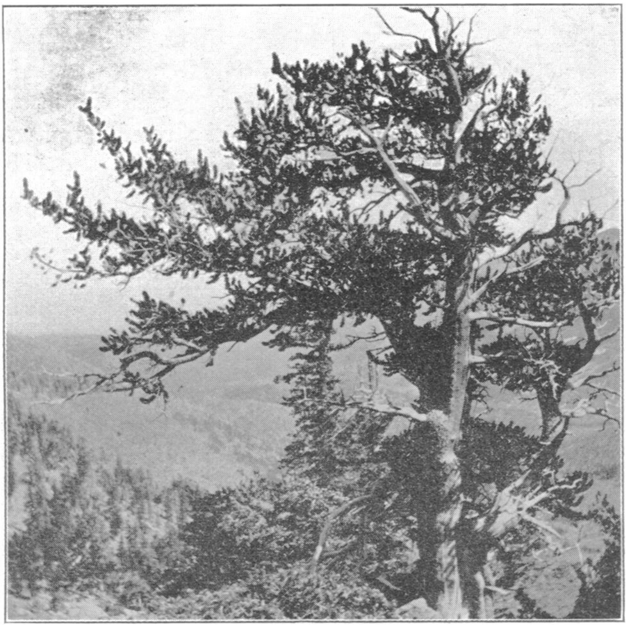
Humphrey Peak, 12,610 feet; Agassiz Peak, 12,340 feet; Cairn on Wing Mt., 8,545 feet; Observatory, 7,250 feet.

With these the aneroïd was corrected to conform as nearly as possible. Without professing accuracy, the results were sufficient for the purpose.

II.

On September 11, the first exploration was undertaken; a camping trip to the Jack Smith spring. This spring, from which a long pipe-line round the hills supplies Flagstaff with water, rises in the crater of the San Francisco Peaks at a height of nearly 10,000 feet above the sea. The way to it lies along the Tuba City road to a point due east of the Peaks and thence up, over a ridge, into the crater. The crater is by no means perfect of form, but resembles a trough five miles long enclosed by high walls on three sides and winding through the fourth to an exit N. N. E. Its vestibule, so to speak, is entered over the ridge mentioned, and stands at about 8,500 feet. It is an open meadow from which one rises by a wooded valley a couple of miles to the lower spring (9,350 feet). In this crater, dominated above the trees by the far rampart of the bare crater wall, the lowest *Pinus Flexilis,* the Rocky Mountain pine, appeared at 8,750 feet, while the Yellow Pine straggled on two hundred feet higher till it gave over at 8,950 feet.

At 9,000 feet occurred the first specimen of the beautiful Cork Fir (*Abies subalpina*), which from there up became the chief tree of the forest. This surprising and truly spectacular fir is a peculiarity of the San Francisco Peaks. Relatively so unknown that botanists visiting the region are taken to see it at their own request, it has not yet found its way generally into the tree-books. Britton's recent exhaustive volume on the trees of North America, for instance, has no mention of it. Its cork jacket is its oddity, but this does not detract from its superb beauty. Its bark, when youthful, is a lustrous white, and its silvery blue young leaves combine to an effect of color ethereality impossible to describe. It continues on some distance above the lower spring and is throughout associated with the Silver Fir (*Abies concolor*), the Douglas Fir, the Rocky Mountain pine, and the Quaking Asp, large patches of the latter replacing the Fir in disastrous fires of the past. A particularly bad one of these forest fires occurred some twenty odd years ago, high up on the southern walls in the spruce zone, too high for the scar-healing Asp, and shows all its ghastly destructiveness to-day. The upper spring lies at 10,070 feet, and just above it occurs the first Engelmann Spruce at 10,100 feet in a dense forest filling an upper valley between Pigeon Ridge, so named for being a favourite resort of the wood pigeon,—a relative of the western carrier pigeon of bygone story,—and a high spur from Humphrey.



FOX TAIL PINE. 11,200 FT.
Slopes greatlv flattened by the camera.

Over the end of this spur, on the morning following their arrival at the spring, Doyle and the writer struck into another more denuded gorge, north and west, and so to a long couloir of *dêbris,* up which they climbed at a steep angle. The first Fox-Tail pine on this slope, which fronted south, stood at 10,600 feet, crowning a promontory of rock bordering the couloir—one of the remnants of the old crater jaws. Some of these remains of Tertiary times were very fine, towering, castellated pinnacles of red rock, fangs in look as well as fact. When not too steep, they made perches for the Fox-Tail pine or the Engelmann Spruce, which thus overlooked not only the crater, but actually the dips between the peaks of the southern crater wall off into the desert, far vistas in vignette. The writer pushed up to a point somewhat below the crowning rampart of rock, the barometer (corrected) showing 11,400 feet, whence by giant strides he coasted down to Doyle through the loose gravel of the slide, a particularly exhilerating mode of descent. There on one of the promontories under the lea of a Fox-Tail pine, they had lunch at 11,200 feet, surveying the wildness and wandering in anecdote down the vista of time.

THE BABY BEAR IN THE TRAP.

Not far from the bottom of the slide in the centre of the secluded ravine they passed on their descent a ruined hut, inside of which Doyle spied a rusty trap and in it the desiccated remains of a baby bear. The poor little chap must have been caught there the winter before. This was the nearest they came to seeing any living thing beside the pigeons and an eagle, though mountain sheep and bear were here once plentiful. Properly doctored, it made a good bear-story on the return to camp; and would have made a better, had not the hearers, as invariably happens, doubted the only part of it that was true.

(*To be continued.*)

DECLINE OF FARMING IN SOUTHERN-CENTRAL NEW YORK.*

BY

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The farming population of parts of the East has suffered a general decrease for several decades as a result of westward migration, and of movement from the farms to the cities. The abandoned farms of hilly New England have been much talked about and, recently, attention has been directed to the similar condition in New York, where 20,000 farms are for sale.†

In connection with studies of the geology of southern-central New York, I have driven much over the country roads of this section, and have been astonished at the evidence of general decline in the farming industry, especially in the hilly sections. Abandoned houses in all stages of decay abound, and in some cases the forest is encroaching on the pastures. Generally, however, the farms themselves are not abandoned, but are worked by neighbouring farmers. Occasionally an abandoned schoolhouse is seen, and the less frequented roads have in many instances been left to the elements.

I have endeavoured to find out whether the region of my studies is declining more than other parts of the State, and if so, why. For the purpose of this study a group of seven counties was selected—Broome, Tioga, Chemung, Schuyler, Yates, Tompkins and Cortland—forming a fairly compact group extending from the Pennsyl-

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* The statistics in this article are from the various reports of the National Census; and those for 1905, from the recent State Census.

† State of New York—Department of Agriculture—Bureau of Information and Statistics, Bulletin No. 1, 1906.